

Indicator: U.S. Homes Above EPA's Radon Action Levels (013)

Radon is a radioactive gas. It comes from the decay of uranium that is naturally occurring and commonly present in rock and soils. It typically moves up through the ground to the air above and into a home through pathways in ground contact floors and walls. Picocuries per liter of air (pCi/L) is the unit of measure for radon in air (the metric equivalent is Becquerels per cubic meter of air or Bq/m³).

Each year radon causes an estimated 21,000 lung cancer deaths in the United States (17,260 among smokers and 2,740 among never-smokers). Radon is the second leading cause of lung cancer after smoking, and smokers are at higher risk of developing Radon-induced lung cancer. Radon accounts for about 13% of all lung cancer mortality (EPA, 2003). Because radon remains a serious public health issue, Dr. Richard Carmona, the U.S. Surgeon General, on January 13th 2005 issued a national Radon Health Advisory.

The lung cancer risk from exposure to radon in the indoor air of homes has been confirmed by case control studies involving both European and North American homes (Darby et al. 2005, Krewski et al. 2005). The earlier EPA risk assessment and that of the National Research Council/NAS were based on the risk to miners extrapolated to homes (NRC 1999, EPA 2003).

The *National Residential Radon Survey* (EPA 1992), found that the average indoor radon level in the United States to be about 1.25 pCi/L. The risk assessments cited above generally assumed a lifetime exposure to this average indoor level. To reduce the risk of lung cancer, EPA has set a recommended "action level" of 4 pCi/L for homes. At that level, it is cost-effective for occupants to reduce their exposure by mitigating their home. In about 70% of cases, a properly installed mitigation system will reduce the indoor radon level to 2 pCi/L or less most of the time. Typically, a home is mitigated based on the average of two radon measurements for real estate transactions. A measurement to confirm the (lower) radon level and proper operation of the mitigation system is typically made following installation.

This indicator is based on: (1) the number of U.S. homes estimated to be at or above the EPA recommended radon action level of 4 pCi/L, i.e., homes with an elevated radon level based on Census data and EPA's National Radon Residential Survey (1992); and (2) the number of homes with operating radon mitigation system. The gap between the homes in (1) and in (2) is the number of homes that have not yet been mitigated (generally, homes are only mitigated if the EPA recommended radon action level of 4 pCi/L or more is measured). The number of homes above 4 pCi/L was derived from U.S. Census data to be consistent with the estimates originally developed in the (radon) *Technical Support Document* (TSD). The number of homes with an operating mitigation system (HOMS) was developed from radon vent fan (RVF) sales data provided voluntarily by fan manufacturers.

What the Data Show

There has been a 370 % increase in the number of homes with an operating mitigation system in 2004 compared to those mitigated in 1990, from 155,000 to 577,000 over 14 years (Figure 013-1). There has been a 126% increase in the estimated number of homes with radon levels greater than 4pCi/L, from about 5 million to 6.3 million over 14 years.

It has been reported anecdotally that radon vent fans/mitigation systems are also being used to control for soil gases/intrusion in homes in the vicinity of RCRA, Superfund, UST/AST and similar sites as an element of corrective action plans. While fans used in this way may provide a radon reduction benefit, they could be considered a subtraction from the number of homes with an operating mitigation system, thus reducing slightly the slope of the trend line.

Indicator Limitations

- The indicator presumes that radon vent fans are used for their intended purpose; the available information supports this premise.
- Homes where the vent fan has failed and has not been replaced have not been added back into the pool of elevated homes.

Data Sources

U.S. Environmental Protection Agency. *National Radon Residential Survey: Summary Report*, EPA 402-R-92-011. Washington, DC; US Environmental Protection Agency, Office of Air and Radiation, October 1992. (*Report is not available online*)

U.S. Environmental Protection Agency. *Technical Support Document*, EPA 400-R-92-011, Mat 1992.

U.S. Environmental Protection Agency. *Homes With Operating Mitigation Systems*, unpublished industry data; Indoor Environments Division, Washington DC; 2005.

References

S. Darby et al. 2005. Radon in Homes and Risk of Lung Cancer: Collaborative Analysis of Individual Data From 13 European Case-Control Studies. *British Medical Journal*, 330 (7485): 223.

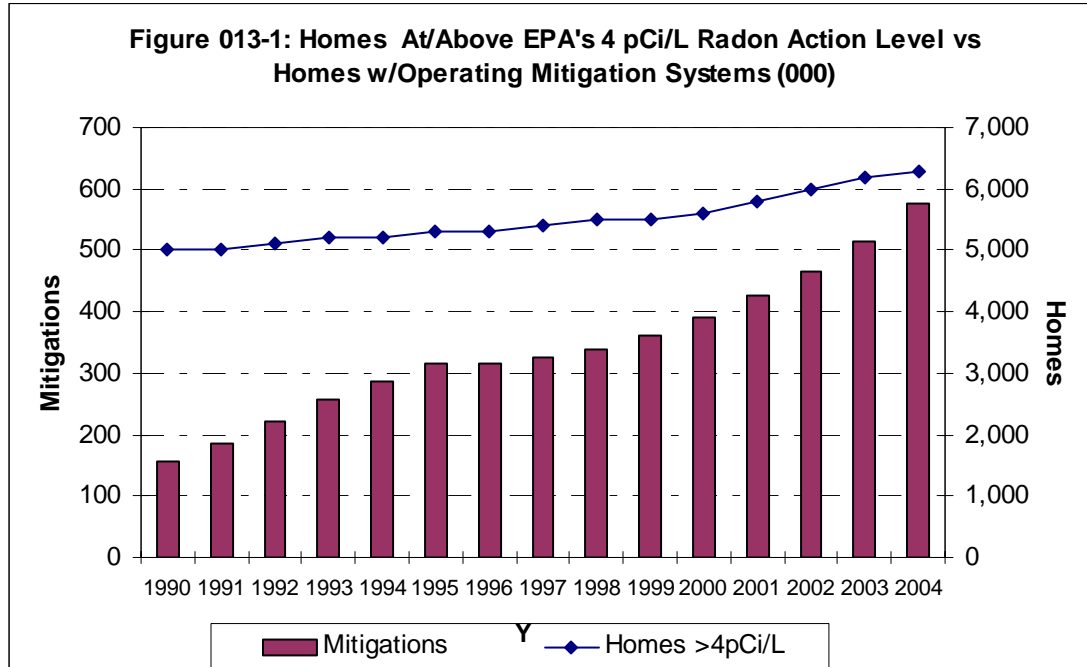
D. Krewski, J.H. Lubin, J.M. Zeilinski, M. Alavanja, V.S. Catalan, R.W. Field, et al., 2005. Residential Radon and Risk of Lung Cancer: A Combined Analysis of 7 North American Case-Control Studies, *Epidemiology* (2):137-45.

National Research Council (NRC), 1999. *Health Effects Of Exposure To Radon: BEIR VI*, National Academy Press, (<http://www.epa.gov/iaq/radon/beirvi.html>)

U.S. Environmental Protection Agency. 1992. *National Radon Residential Survey: Summary Report*, EPA 402-R-92-011. Washington, DC; US Environmental Protection Agency, Office of Air and Radiation, October.

U.S. Environmental Protection Agency. 2003. *EPA Assessment of Risks from Radon in Homes*, EPA 402-R-03-003. Washington, DC; US Environmental Protection Agency, Office of Radiation and Indoor Air, (www.epa.gov/radiation/docs/assessment/402-r-03-003.pdf)

Graphics



R.O.E. Indicator QA/QC

Data Set Name: US HOMES ABOVE EPA'S RADON ACTION LEVEL

Indicator Number: 013 (118091)

Data Set Source:

Data Collection Date:

Data Collection Frequency:

Data Set Description: US Homes Above EPA's Radon Action Level

Primary ROE Question: What are the trends in indoor air quality and it's effects on human health?

Question/Response

T1Q1 Are the physical, chemical, or biological measurements upon which this indicator is based widely accepted as scientifically and technically valid?

In making physical measurements of radon in air, the established radon measurement industry in the U.S., EPA believes, generally make them consistent with EPA, state and industry protocols and quality assurance guidance. Measuring radon (radiation) in homes is well understood and has been widely practiced since the mid-1980's. (Protocols for Radon and Radon Decay Product Measurements in Homes, EPA 402-R-92-003, May 1993)

T1Q2 Is the sampling design and/or monitoring plan used to collect the data over time and space based on sound scientific principles?

There are two types of data at issue here. First, the data on the number of homes above the EPA action level was generated based on a template first used in the Technical Support Document (TSD)(EPA 402-R-92-011, May 1992) created to support development of EPA's 1992 A Citizen's Guide to Radon (EPA 402-K02-006, May 2004) and the Home Buyer's and Seller's Guide to Radon (EPA 402-R-00-008, July 2000). That template and subsequent application of it are based on U.S. Census housing/population data tables. The TSD (and its derivative documents) was extensively peer reviewed, including by the EPA Science Advisory Board (SAB) and stakeholders. Second, the data on the number of homes with operating mitigation systems is derived from radon vent fan sales data. The primary sources for this data are three radon vent fan manufacturers that are responsible for 99% of the market. Annual updates solicited by EPA from these manufacturers yield data on the number of radon vent fans sold, their potential non-radon application or use, and estimates of their useful life (the latter is also checked against similar information from practicing mitigation practitioners in the field). Individual company information is treated as confidential business information (CBA). Only homes that have had a radon measurement are mitigated. Following mitigation, a test confirming reduction of the radon level to less than 4 pCi/L is routinely made.

T1Q3 Is the conceptual model used to transform these measurements into an indicator widely accepted as a scientifically sound representation of the phenomenon it indicates?

The approach (described in T1Q2) and the data have been peer-reviewed attendant to publication (web) of earlier versions of the Radon Progress Report, and other documents prepared for internal EPA use (e.g., briefings, fact sheets, etc., for use by management). Variations on this approach have been used by the Agency since the early-1990s. This indicator is as direct and unencumbered a measure of risk reduction as is currently available within the existing limitations.

T2Q1 To what extent is the indicator sampling design and monitoring plan appropriate for answering the relevant question in the ROE?

As a measure of public health and risk reduction this indicator is the most appropriate currently available.

T2Q2 To what extent does the sampling design represent sensitive populations or ecosystems?

T2Q3 Are there established reference points, thresholds or ranges of values for this indicator that unambiguously reflect the state of the environment?

The most relevant reference points, thresholds and ranges of values are these: (1) EPA's public action level of 4 pCi/L; (2) the average indoor radon level of 1.25 (1.3) pCi/L; (3) the effectiveness of radon mitigation, i.e., radon reductions to less than 2 pCi/L in 70% of residential mitigations; (4) Census data as the basis for estimating the number of homes above the action level (1); and (5) the range of homes estimated to have an operating mitigation system based on three data points reflecting the useful life of a radon vent fan (i.e., 8, 10 and 12 years). All of these values (data) were established through valid survey, assessment and study designs.

T3Q1 What documentation clearly and completely describes the underlying sampling and analytical procedures used?

This information is documented in the draft chapters Homes With Operating (Active) Mitigation Systems and the Scope of the Radon Risk in Homes from the (as yet) unpublished Radon Progress Report (Jalbert, et al., Draft 2005). An earlier version of this report is available on the IED website (http://www.epa.gov/iaq/radon/images/natl_radon_results_update.pdf). The base Census data is publicly available.

T3Q2 Is the complete data set accessible, including metadata, data-dictionaries and embedded definitions or are there confidentiality issues that may limit accessibility to the complete data set?

The complete data set for radon vent fan sales by year and by company is not available due to business confidentiality limitations imposed by the providers. (Phil Jalbert, 202-343-9431, jalbert.philip@epa.gov).

T3Q3 Are the descriptions of the study or survey design clear, complete and sufficient to enable the study or survey to be reproduced?

Yes. This information is contained in EPA program staff files and to a lesser (but sufficient) degree in the draft or published above cited reports.

T3Q4 To what extent are the procedures for quality assurance and quality control of the data documented and accessible?

The quality/integrity of the Census data is presumed adequate. The quality/integrity of the manufacturer provided data is presumed sufficiently accurate given that it is primary (unaltered) sales data.

T4Q1 Have appropriate statistical methods been used to generalize or portray data beyond the time or spatial locations where measurements were made (e.g., statistical survey inference, no generalization is possible)?

Not Applicable.

T4Q2 Are uncertainty measurements or estimates available for the indicator and/or the underlying data set?

Yes. For one-half the indicator, i.e., the number of homes with an operating mitigation system (HOMS), a range (8-10-12 years) has been developed based on the estimated useful life of radon vent fans generally (see also T2Q3).

T4Q3 Do the uncertainty and variability impact the conclusions that can be inferred from the data and the utility of the indicator?

Yes. However, IED's current preference is to use the central estimate in the range of a radon vent fan's useful life, i.e., 10 years (see also T2Q3, T4Q2). T4Q4. Are there limitations, or gaps in the data that may mislead a user about fundamental trends in the indicator over space or time period for which data are available? Currently there are none known or quantified. However, a potential limitation exists that IED is investigating, i.e., the use of radon vent fans/mitigation systems in non-radon applications. It has been reported anecdotally that radon vent fans/mitigation systems are being used to control for soil gases/intrusion in homes in the vicinity of RCRA, Superfund, UST/AST and similar sites as an element of corrective action plans.

T4Q4 Are there limitations, or gaps in the data that may mislead a user about fundamental trends in the indicator over space or time period for which data are available?